Our Reference: PAR-115-D PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Allan McCarty

Serial Number: 10/616,820

Filing Date: July 10, 2003

Examiner/Art Group Unit: Mark Graham/3711

Title: BILLIARD CUE

DECLARATION

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

I, Allan McCarty, declare as follows:

1. I am an individual residing at 5055-5 St. Augustine Road, Jacksonville, Florida 32207 and am co-inventor along with Steve Titus of the invention described and claimed in the above-identified application.

2. I have played pool for at least 25 years at the expert or professional level.

3. Since my founding of Clawson Cues, Inc. in 1992, I have conducted research, made and sold pool cues and pool accessories.

4. In the early 1990's , I developed "Iron Willie" which is a pool-playing robot which I use to empirically test pool cue performance. Iron Willie made it possible to hold all variables constant and to scientifically compare various cue designs through precisely controlled, repeatable shots.

5. Spin or English is produced by striking the cue ball off center. This allows the player to control the movement of the cue ball around the table. However, an undesirable effect of using English is cue induced cue ball deflection. Simply, the cue ball does not go where it is aimed by the cue stick itself. Some cues can deflect the cue ball up to 1.5 inches from the intended path of movement of the cue ball. The amount that the cue ball deflects depends on the cue, how far off center the cue ball is struck, the speed of the shot, the distance to the object ball and the nature of the applied stroke. This is shown in Figs. 4A and 4B of the above-identified application.

6. As a result of making thousands of precisely controlled shots using Iron Willie, the amount of cue ball deflection by various cue designs was accurately measured. Eventually a 12,000 frame per second high speed camera was employed to photograph cue impact with a cue ball and the resultant path of movement of the cue ball and any deflection.

7. As a result of this research, old assumptions were disproved and new ideas were originated. My research has shown that approximately the first 10 inches of a cue is more

important than any other part of the cue in terms of performance. How the first 10 inches bends and compresses upon impact with the ball, and how it allows the cue ball weight to displace the shaft have been found during my research to the have the greatest effect upon cue ball deflection.

8. A ferrule made of a material and design that reduced the tendency of the shaft to buckle upon impact when struck off center was originated as described in US Patent No. 5,725,437.

9. When the cue ball is struck off center, as the ball starts to rotates, the tip stays in contact and rotates off the side of the ball, see Fig. 4A of the subject application. The conventional wood shaft is stiff, heavy and tends to remain in place. The only force to move it aside is the weight of the cue ball. I have discovered through research that the weight and stiffness of the front end of the shaft is critical as to how much cue ball deflection the shaft produced. When one gram of weight is added to the tip end of a shaft, cue ball deflection is increased by 16%, two grams of added weight increase deflection by 28%. Conversely, I have found that by reducing the weight in the front end of the shaft, cue ball deflection decreases.

10. In US patent application, Serial No. 08/825,249, I disclosed that an effective way to reduce weight at the front end of the shaft was to bore a hole down the first 5 inches of the shaft from the tip end. Five inches work better than 4 inches. A 6 inch bore is not significantly better than a 5 inch bore. The larger the diameter of the bore, the less cue ball deflection was produced. I constructed a shaft having a 0.25 inch bore in a 0.5 inch diameter shaft. This bore reduced the weight of the shaft by approximately 30%, but only reduced the shaft's relative stiffness by approximately 10%. A wooden shaft constructed with this stiffness to weight ratio technology reduced cue ball deflection by 35% over conventional shafts.

11. In US patent application, Serial No. 08/825,249, I mentioned the potential of using composite materials to form the shaft due to their much greater stiffness to weight ratio. Graphite shafts marketed today are engineered to have that same properties of wood with respect to weight and stiffness. In fact, all of the graphite shafts made today and measured through my research, have either the same or worse playing characteristics as conventional wood shafts. A graphite shaft with a wall thickness of approximately 0.060 inches will produce the same amount of cue ball deflection as a standard wood shaft.

12. As a result of my research, I have discovered that the wall thickness and stiffness of a composite shaft is critical to the amount of cue ball deflection produced by the shaft. Thinner is better and is also lighter. A first composite shaft which I made was formed of carbon fiber with a wall thickness of approximately 0.03 inches in the front end for a distance of at least 5 inches in a 0.50 outer diameter shaft, which is less than one half the wall thickness of any prior art composite shaft which have wall thicknesses, typically surrounding wood or plaster of about 0.74 to 0.80 inches. This is due to the need to make the total cue weight be between 18 and 19 ounces to feel like a conventional wood cue. The results in terms of cue ball deflection were as I predicted and were

unknown in the pool art. This prototype reduced cue ball deflection by at least 50% over any tested composite or conventional wooden shaft.

13. Thus, I found that wall thickness and stiffness at the first end of a hollow bore in a cue shaft is critical to reducing cue ball deflection. The prior art does not.recognize the impact of wall thickness and stiffness on cue ball deflection. Thus, the significant reduction in cue ball deflection by a cue shaft constructed according to the claimed elements of my invention in the subject application produces significant advantages over any prior art shaft, whether formed of wood or composite materials.

14. The results of my testing with respect to small wall thicknesses and specific stiffness to weight ratio at the tip end of a cue shaft, while not totally unexpected since I came to realize, as a result of testing and measuring cue ball deflection in thousands of cue shafts, the wall thickness is critical to decreasing cue ball deflection; nevertheless represents an entirely new concept not recognized in prior art cue design. As such, it is my opinion that the elements of my invention as set forth in the claims of the subject application represent new subject matter not taught or suggested in any prior art reference.

15. The attached paper which I have prepared demonstrates tests made on the Predator Z shaft which is the subject matter of the claims of the above identified application. This paper includes theoretical subject matter developed by Joseph Lewandowski and supported by his own declaration submitted currently with this declaration. As a result of these tests, it is my opinion that the Predator Z shaft having a structure set forth in the claims of the above-identified invention has 43% less deflection than a solid wood traditional shaft and the predecessor Predator 314 wood shaft which has a similar tip end bore configuration and a corresponding stiffness/weight ratio or specific modulus of elasticity as in as in the claims of the above-identified application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Allan McCarty

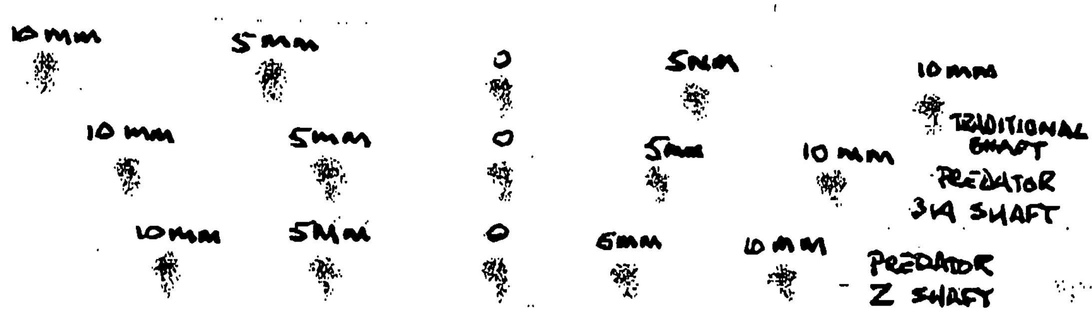
Allan McCarty

Date: 7-29-04

Objective:
This exercise is to show how Predator's bored tip end produces less cue ball deflection when compared to the industries standard solid wood cue.

Procedure:
The diagram below shows the deflection results from three different cues tested in the lab on June 27, 2004 at Predator. Our reliable robot, Iron Willie, shot the three cues five times each. The first shot was in the center of the ball to give the reference point for further shots. The second and third shot were taken 5mm's off-center toward the left and right respectively. Finally, the fourth and fifth shot were taken 10mm's off-center toward the left and right respectively. All factors such as cue ball speed, tip shape, spring pressure, bridge length, and chalk placement were kept constant for reliability of consistency of results.

Results:



As you can see, the traditional shaft's dots are more spread out than Predator's 314 and Z shaft. The Traditional shaft created much more cue ball deflection during the off-center shots than Predator's 314 or Z shaft. This is because the traditional shaft does not have a bore through the center of the tip, and therefore has a higher Specific Modulus of Elasticity. Specific Modulus of Elasticity is the stiffness to weight ratio of the cue. The theory supporting the lower cue ball deflection demonstrated by the 314 and the Z can be shown through two exercises. The first is from the kinematics perspective, and it will show that the cue with the smallest end mass will be pushed out of the way by the ball, instead of the cue pushing the ball out of the way. The second exercise will show that the geometry created by the bored tip is more conducive to bending than the traditional shaft. This again allows the shaft to bend out of the way of the cue ball, instead of the shaft pushing the cue ball out of the way.

Exercise 1: Kinematics

The system will be defined as the cue and the cue ball. While the cue does bend, we will assume it is rigid for this exercise. Therefore, we can make the assumption of an elastic collision. The momentum equation of an elastic equation follows:

$$(m_{cue} * v_{cue})_{initial} + (m_{ball} * v_{ball})_{initial} = (m_{cue} * v_{cue})_{final} + (m_{ball} * v_{ball})_{final}$$

The ball is initially at rest, so the $(m_{ball} * v_{ball})_{initial}$ term goes to zero. This leaves the equation solved for $(v_{cue})_{final}$ as:

$$(v_{cue})_{final} = \frac{(m_{cue} * v_{cue})_{initial} - (m_{ball} * v_{ball})_{final}}{m_{cue}}$$

For the tests [illegible] or, the ball velocity was 6.5 mph down the table, and the cue ball mass was .17 kg. The density of maple is 44.2 lbs /ft^3. With these constants known, one can easily calculate the differences in $(v_{cue})_{final}$ when the m_{cue} is lower due to the bore in the tip end.

Cue Name	Tip End Density (lbs/ft3)	Tip End Volume (mm3)	Tip End Mass (g)	% Less Mass Than Traditional
Traditional	44.2	796.4	0.5639	0.00%
314	44.2	47.5	0.0336	94.04%
Z	44.2	43.7	0.0309	94.51%

Now one can easily see the correlation between the drop in tip end mass, and the increases in $(v_{cue})_{final}$. The higher $(v_{cue})_{final}$, the quicker the cue can get out of the way of the cue ball, and therefore less deflection will be seen.

Exercise 2: Deformation and the Modulus of Elasticity

The amount the tip bends away from the ball is measured as (Y). (Y) can be calculated through the following material mechanics equation:

$$Y = \frac{PL^3}{3EI}$$

It is evident in this equation that a lower Modulus of Elasticity will increase the amount the tip of the shaft moves from its initial location. Both cues are made of maple, so both have the same Modulus of Elasticity. However, (I), the Second Moment of Area, is very different between the cues because of the bored out tip. The Second Moment of Area can be found for both a solid wood Traditional shaft, and for Predator's 314 and Z shaft which has a bored out center.

<u>Traditional Solid Wood Shaft</u>

$$I = \frac{\pi R^4}{4}$$

Predator's 314 and Z Shaft

$$I = \frac{\pi R_{outside}^4}{4} - \frac{\pi R_{inside}^4}{4}$$

The difference in (I) can easily be seen in the following table:

Cue	Outside Radius (mm)	Inside Radius (mm)	I (mm4)	% Less Than Traditional
Traditional	6.5	NA	1401.27	0.00%
314	6.4	6.2	157.07	88.79%
Z	5.9	5.7	122.57	91.25%

These calculations clearly show how much lower (I) is for a shaft with a bored out tip end. This lower (I) will allow the tip of Predator's 314 and Z shaft to bend out of the way of the ball during contact of an off-center shot. This deformation of the cue will create less cue ball deflection than the solid Traditional shaft.

Conclusion:
This exercise was to show though experimentation and theory that a cue with a bore through the center of its tip will cause less cue ball deflection. The tests were done on three different cues. The first was a solid wood Traditional shaft. The second was Predator's 314 shaft with its bored tip end, and finally Predator's Z shaft which has a bored tip end.

The empirical data shows Predator shafts produce much less cue ball deflection than the solid wood Traditional shaft. Predator's 314 shaft had 31% less deflection, and Predator's Z shaft had 43% less deflection.

This empirical data was then supported by theoretical formulas pertaining to Kinematics, Modulus of Elasticity, and deformation. All three subjects were explained, examined, proved, and applied to the data produced through Predator's experimentation.

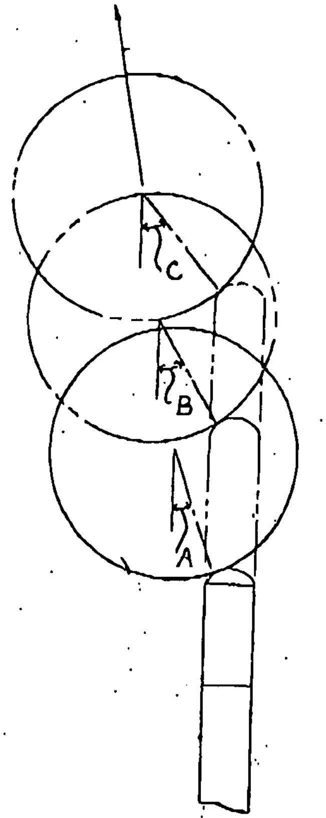


FIG 1

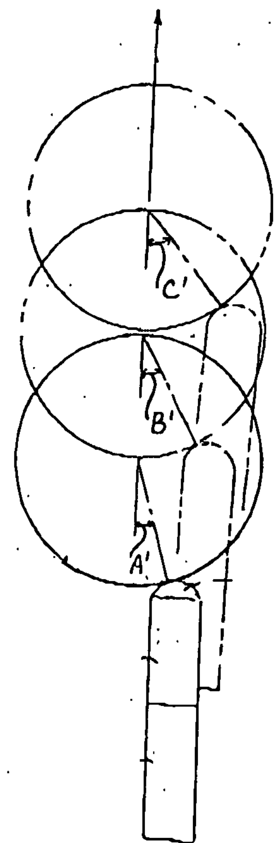


FIG 2

Fig. 1

The Shaft with the ~~higher~~ lower specific modules wants to push through the cue ball (cue-ball deflection).

Fig. 2

The shaft with the ~~lower~~ higher specific modules is pushed aside by the cue ball (reducing cue ball deflection).

Our Reference: PAR-115-D PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Joseph Lewandowski
Serial Number:	10/616,820
Filing Date:	July 10, 2003
Examiner/Art Group Unit:	Mark Graham/3711
Title:	BILLIARD CUE

DECLARATION

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

I, Joseph Lewandowski, declare as follows:

1. I am an individual residing at 1715 Hodges Boulevard #1904, Jacksonville, Fl 32224.

2. I am currently an engineering student at the University of North Florida, Jacksonville, Florida, and have completed 3 ½ years of an expected four (4) year program which will result in a degree in Mechanical Engineering in 2004.

3. At the request of Clawson Custom Cues, Inc., I analyzed the construction and operation of the Predator wood cues, the composite cue forming the subject matter of the above-identified US Patent Application. Based on my review, I developed the attached explanation of the dynamic operation of the cues which explanation is to be considered part of this declaration.

4. Also at the request of Clawson Custom Cues, Inc., I compared the construction of the Predator Z composite cue as defined in the claims of the above-identified application with each of the references cited by the Examiner and the Examiner's reasons for citing such references. Based on this review, it is my opinion that each reference fails to teach or suggest the subject matter set forth in the claims of the above-identified application for the following reasons:

4a. (Lo) The shaft of Lo is made rigid to reduce deformation. The ferrule has a plug inserted into the front end of the shaft so that a hollow bore does not exist or extend from the tip end of the shaft. The front end of the shaft and the solid front connectors are made from carbon fiber so that "the rigidity of the cue is simultaneously increased" (Lo, page 4 lines 21-27). The carbon fiber has a higher modulus of elasticity and is more rigid than wood. This increased rigidity and increased tip end weight will, in my opinion, increase cue ball deflection.

4b. (Ghezzi) The length of the tip bore in Ghezzi is not defined. Any weight reduction achieved by the formation of the bore in the tip end of the shaft of Ghezzi is out weighed by the mounting of the metal spring wire tip fastening device in the bore. This metal spring increases mass thereby offsetting any mass or weight reduction made by the use

of the bore. Further, the metal fastener will increase the rigidity of the tip end of the bore thereby increasing cue ball deflection over that of the conventional wood shaft without a bore and tip mounting.

4c. (Seeman) The shaft of Seeman is made of a metal, with aluminum beads specifically described. A shaft formed of aluminum, even with a hollow interior bore shown by Seeman, will have increased mass as compared to a conventional wood shaft of the same construction. Aluminum is also substantially more rigid than wood. As a result, the increased rigidity and weight or mass will increase cue ball deflection as compared to a conventional wood cue. Seeman is devoid of any teaching of forming the bore to extend from the tip end of the shaft. The converging tapered cross section of the bore in Seeman would appear from the drawing to end substantially short of the tip end.

5. The cited references are devoid of any understanding or use of a tip end bore extending for about 4-5 inches from the tip end of the shaft which creates a shaft wall thickness surrounding the bore with a sufficient stiffness so that the overall stiffness/weight ratio, or specific modulus of elasticity, of Applicant's claimed cue will enable transverse deflection of the tip end of the cue shaft on an off center strike on a cue ball to minimize cue ball deflection from its intended path of movement. Any of the bores found in the cited references have the shafts formed of a material or in a manner which increases shaft rigidity and tip end mass or weight. This is directly opposed to the teachings of Applicant's invention as defined in the claims of the above-identified application and results in increased cue ball deflection as compared to Applicant's unique cue shaft.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Joseph Lewandowski

Date: 7-29-2004

Modulus of Elasticity (E):
The Modulus of Elasticity is the slope of the straight line portion of the stress-strain diagram. It is the ratio which compares the stress applied to a material to the strain of the material.

$$E = \frac{\sigma}{\varepsilon}$$

$$\sigma = Stress = \frac{F}{A}$$

$$\varepsilon = Strain = \frac{\delta}{L}$$

When referring to the tip of a cue as it makes contact with the cue ball, we have found a low Modulus of Elasticity is preferable. Through our research and testing, we have concluded that the low Modulus allows the tip of the shaft to bend, therefore allowing the shaft to remain in contact with cue ball longer when an off center shot is taken. This bending has been theoretically and empirically proven to reduce cue ball deflection in our labs.

Below is an exercise which will help illustrate how Predator's low Modulus of Elasticity gives it an advantage over the industries conventional solid wood cues.

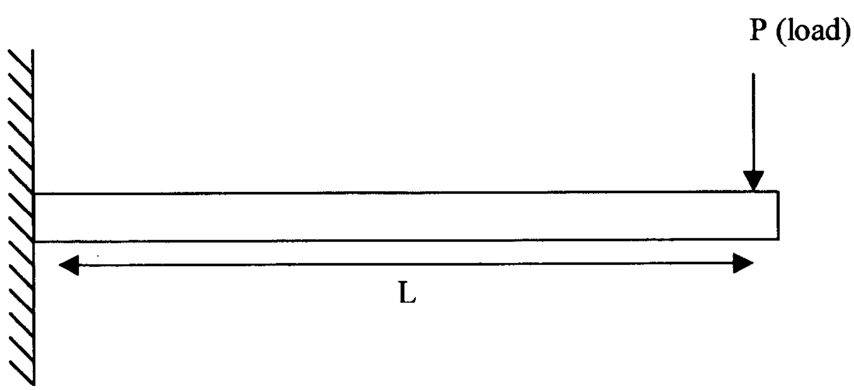


Figure 1: Diagram of a shaft with length (L). The left side is rigidly mounted and the right side is under the load (P).

The shaft above is loaded on the tip in the same manner as the cue ball exerts a force on the shaft during an off-center shot. While the bridge a player creates while holding a cue is not rigid, the rigid assumption has been made to help simplify this exercise. The translation of the shaft away from the cue ball which happens when the bridge is not rigid will be discussed in the following section. The load (P) on the tip of the cue will cause the shaft to bend away from the ball.

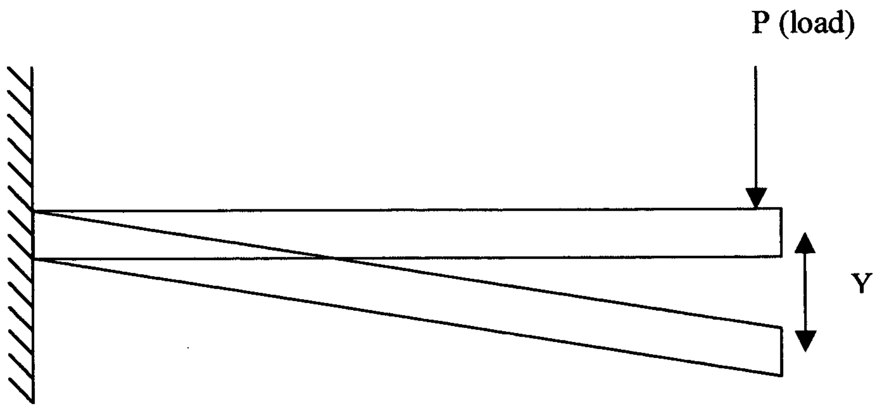


Figure 2: Diagram of the deformation (Y) of a shaft under the load (P).

The amount the tip bends away from the ball is measured as (Y). (Y) can be calculated through the following material mechanics equation:

$$Y = \frac{PL^3}{3EI}$$

It is evident in this equation that a lower Modulus of Elasticity will increase the amount the tip of the shaft moves from its initial location. (I) is the Second Moment of Area. The Second Moment of Area can be found for both a solid wood shaft, and for Predator's 314 shaft which has a bored out center.

<u>Traditional Solid Wood Shaft</u>

$$I = \frac{\pi R^4}{4}$$

<u>Predator's 314 Shaft</u>

$$I = \frac{\pi R^4_{outside}}{4} - \frac{\pi R^4_{inside}}{4}$$

These equations illustrate how the bored out center of Predator's shafts reduce the Second Moment of Area, and therefore increases the amount a Predator shaft will bend away from the cue ball during an off-center shot. This bending allows the tip to remain in contact with the ball longer, and therefore reduces the amount of cue ball deflection.

Kinematics of a Collision
In the previous section we discussed the effects that Modulus of Elasticity and Second Moment of Area had on the amount a shaft bends during an off-center shot. This allows the cue ball to remain on its intended path while the shaft bends out of the way. This is only one factor in what occurs during the collision of the cue and the cue ball. The shaft not only bends, but also translates out of the way of the cue ball. This section will show how the lower end mass of the cue allows for easier translation of the cue tip.

The system will be defined as the cue and the cue ball. While the cue does bend, we will assume it is rigid for this exercise. Therefore, we can make the assumption of an elastic collision. The momentum equation of an elastic equation follows:

$$(m_{cue} * v_{cue})_{initial} + (m_{ball} * v_{ball})_{initial} = (m_{cue} * v_{cue})_{final} + (m_{ball} * v_{ball})_{final}$$

The ball is initially at rest, so the $(m_{ball} * v_{ball})_{initial}$ term goes to zero. This leaves the equation solved for $(v_{cue})_{final}$ as:

$$(v_{cue})_{final} = \frac{(m_{cue} * v_{cue})_{initial} - (m_{ball} * v_{ball})_{final}}{m_{cue}}$$

From this equation, one can conclude that as the m_{cue} decreases, the $(v_{cue})_{final}$ increases. Predator has decreased the mass of the cues by boring out the center of the tip. This bore allows the shaft to translate away from the ball easier during an off-center shot. This allows the ball to remain much closer to its intended path, and reduces cue ball deflection.

Our Reference: PAR-115-D PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Karim Belhaj

Serial Number: 10/616,820

Filing Date: July 10, 2003

Examiner/Art Group Unit: Mark Graham/3711

Title: BILLIARD CUE

DECLARATION

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

I, Karim Belhaj, declare as follows:

1. I am an individual and the Chief Operating Officer of Clawson Custom Cues, Inc., the expected manufacturer of the billiard cue, Predator composite material shaft, forming the subject matter of the of the above-identified invention.

2. In 1995, Clawson Custom Cues, Inc. had total annual sales of about $500,000.

3. In 2004, the projected sales of billiard and pool related products by Clawson Custom Cues, Inc. is about $4.5 million. Of these projected sales in 2004, approximately $4.1 million are for the Predator cue utilizing the bore and similar stiffness/unit weight ratio technology to that which is defined in the claims of the subject application.

4. Currently, the Predator cue, which utilizes the similar bore and stiffness/weight ratio technology as set forth in the claims of the above identified application, is being used by more than 50% of the top 50 pool/billiard professionals in the United States (including the 2004 9-ball world champion, Alex Pagulayan). None of these professionals using the subject shaft & cue are paid to use or asked to use the Predator cue or shaft by Clawson Custom Cues, Inc. It is my opinion that the use of the Predator cue by such professionals is due solely to its performance, namely, less cue ball deflection.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Karim Belhaj

Date: July 29th 2004